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## MATHEMATICAL ASPECTS OF ELECTRICITY AND MAGNETISM.

*The Mathematical Theory of Electricity and Magnetism.* By Prof. J. H. Jeans, F.R.S. Pp. viii+536. (Cambridge: University Press, 1908.) Price 15s. net.

ELECTRICITY and magnetism now form so vast a subject that their mathematical aspects cannot be all dealt with in a single volume even of the present size. Thus a choice has to be made by the author, and one's estimate of his success naturally depends to some extent on what one believes most appropriate for the type of reader whose wants he professes to supply. In his preface the author tells us that whilst his work covers much the same range as Maxwell's treatise, it is in many respects more elementary; that it is not, like Maxwell's great work, for the fully equipped mathematician, but more especially for the student and for the physicist of limited mathematical attainments.

The difficulties experienced by a good mathematician in Maxwell's treatise arise more from what it omits than from what it contains. The difficulty lies in following Maxwell's train of thought, and in seeing what exactly it is he is trying to prove. There is a substantial substratum of truth in the remark once made to the writer that it would have been an immense improvement to Maxwell's "Electricity" to have been written by Routh. Maxwell's treatise is a work of genius, but it never was a good text-book for students. The distinguished editors of the second and third editions have very naturally treated the treatise as a species of sacred writing, not to be lightly modified even in details, and though Prof. J. J. Thomson's "Recent Researches" appeared as a supplementary volume to the electrical part, it is not a complete treatise in itself. Thus there does appear room for a complete mathematical treatise in English, such as might be written by an accomplished mathematician who had the time, the knowledge, and the natural gifts necessary for clear exposition. The production of such a book, it may be added, need not be regarded as showing any lack of reverence for Maxwell's memory.

Now it seems to the present writer that while Prof. Jeans's eye when he started writing may have been focussed on the reader of "limited mathematical attainments," it gradually extended its range of vision until it viewed in the distance, though but dimly, the complete treatise hinted at above. The result is that the book seems not unlikely to reduce the self-esteem of any conscientious reader of limited mathematical attainments who has no one at hand to advise him what to omit, at least for a first reading.

Chapters i. to viii., pp. 5-294, *i.e.* more than half the book, are devoted to electrostatics. This apparent disproportion the author ascribes to space being given in chapter viii. to the explanation of the mathematics of spherical and ellipsoidal harmonics, conjugate functions, Schwarz's transformation, and similar matters. This chapter is a very long one, dealing

also with inversion and the theory of images, and containing the solution of problems which illustrate the various methods. Chapters ix. and x. deal with currents, mostly steady currents; chapters xi. and xii. treat of "permanent" and "induced" magnetism, including a few pages on terrestrial magnetism. Chapter xiii. deals with the magnetic field produced by steady currents, chapter xiv. with the induction of currents in linear circuits, make and break currents and oscillatory discharges, and chapter xv. with the induction of currents in continuous media and current sheets. The three last chapters, xvi., xvii. and xviii., treat of Hamilton's principle, Lagrange's equations, the general electromagnetic equations, and the electromagnetic theory of light.

An important feature of the book is the insertion of examples for the student at the end of most of the chapters. In all, there are some 250 of these, varying much in difficulty, but mostly of the type characteristic of Cambridge college and university examinations. Another feature is the insertion of numerical results in the text illustrating the size of practical electrical units; these should reduce the risk of mistakes in applications of general formulæ. There are not infrequent references in the text to physical results calculated to warn the student against improper applications of the mathematical theory, but they do not always seem quite adequate. The statement, for instance, p. 400, that magnetic permeability in iron continually increases as temperature is raised up to the point of recalcence is too general. At the end of each chapter is a list of authorities. These lists are, however, mainly devoted to stating which precise part of a few English books (especially Maxwell's treatise and J. J. Thomson's "Elements") deals with the subject of the chapter. A single really good name-index would probably be more generally useful. In the absence of a name-index, the general index, pp. 532-6, seems hardly adequate. It does not contain, for instance, the names of Kelvin, Larmor, Lodge, Rayleigh or Thomson. Amongst the subjects to which little space is devoted are methods of measurement and comparison, the theory of instruments, problems relating to dynamos, electric lighting or traction, and electrical engineering generally, rapidly alternating currents, detailed theories of electrons or moving charges, atmospheric electricity and conduction in gases.

The printing and general appearance are what one expects of the Cambridge University Press. Even Cambridge proof-readers, however, must occasionally miss something, *e.g.*  $\delta^2 V / \delta x$ , p. 59, and  $\iiint dS$ , p. 372.

The signs attached to the Gaussian constants  $B_{11}$ ,  $B_{42}$  and  $B_{44}$  (Neumayer's values) in art. 456 appear to be wrong; but  $B_{11}$  is given the correct sign in art. 457. It seems curious, by the way, that, notwithstanding the great prominence given to Cambridge sources of information, there is no reference to J. C. Adams's great work on the Gaussian constants, or to Shelford Bidwell's article on magnetism in the *last* edition of the "Encyclopædia Britannica" (Prof. Jeans's references seem all to the ninth edition).

In a few cases there are slips which can hardly be assigned to the printer, *e.g.* in the analysis of art. 520, but few such have been noticed. In conclusion, it may be said that in the opinion of the present writer the type of reader for whom the book is best adapted is the student preparing for a mathematical examination, such as the Cambridge Tripos, in which theory plays the principal part. It should also, however, prove a good book of reference to the physicist of superior mathematical attainments. For either of these types of readers it seems likely to be a really useful book, so far as its scope extends.

C. CHREE.

#### PETRELS.

*A Monograph of the Petrels (order Tubinares).*

Parts i., ii. and iii. By Dr. F. Du Cane Godman, F.R.S. With hand-coloured plates. (London: Witherby and Co., 1908.) Price 2l. 5s. per part.

WE welcome another instalment of the finely illustrated "monographs" in which ornithologists are gradually, if slowly, writing the history of the birds of the world. The latest of these monographs to be launched is founded on the synopsis of the order Tubinares, published by the late Mr. Salvin in the twenty-fifth volume of the "Catalogue of the Birds in the British Museum." It was Mr. Salvin's intention on the completion of that work to have issued a series of coloured illustrations representing all the species of petrels, shearwaters, fulmars, diving petrels, and albatrosses, which constitute the order Tubinares, and at the time of his death in 1897 many of the plates had been prepared. The present author has had the series of coloured plates completed, and he is now issuing them in the form of a monograph, adding such synonymy and accounts of the geographical distribution and habits of the species as Mr. Salvin originally intended, and bringing the work up to date.

Since the twenty-fifth volume of the British Museum Catalogue was issued in 1896, considerable additions to our knowledge of the Tubinares have been made. Some remarkable discoveries have been made by American ornithologists in the seas of California and the islands which lie off the south-western coast of North America, and Sir Walter Buller's supplement to the "Birds of New Zealand" has added to our knowledge of the group. Moreover, from the observations made by the naturalists to several recent Antarctic expeditions, we have learned a great deal about the breeding habits of certain well-known species, which, retiring to those inhospitable regions for the purpose of reproduction, had up to then managed to keep us very much in the dark as to the manner of their nesting. The material thus examined has enabled the author to undertake the revision of the Tubinares with some confidence. The order as at present known embraces more than one hundred species.

The first three parts of the work are now in our hands, and fully carry out so far as they go the objects set forth in the author's note. The first part deals with the smaller petrels of the following genera:—*Procellaria*, *Halocyptena*, *Oceanodroma*, *Oceanites*, *Gorrodia*, *Pelagodroma*, *Pealea*, and *Cymodroma* (in

part). First on the list comes our own familiar stormy petrel—the petrel *par excellence*—of which a very good and concise history is given, including synonymy, geographical distribution, breeding, and general life habits, and a full description of the plumage of the adult and young; and this is the general plan of the work.

Twenty-four species are treated of in sixty-eight pages of letterpress, and there are twenty coloured plates. Part ii. concludes *Cymodroma*, and deals with twenty-four species of the large genus *Puffinus*, the shearwaters, in sixty-four pages, with twenty coloured plates. In this part may be noticed the great shearwater, of which, though the bird was known to Latham so long ago as 1785, and although it sometimes appears in large numbers off our own coasts, the breeding place is still unknown. It can scarcely, however, be doubted that this must be sought for in southern latitudes, and in our winter.

Part iii. concludes *Puffinus*, and treats of four restricted genera and twenty-three species of the extensive genus *Œstrelata*. Among the former we find the silvery-grey fulmar of the southern oceans, which in general appearance so much resembles the fulmar of the north that Latham and Gmelin described it as a variety of that species. Also the great dark-coloured petrel familiarly known to sailors as the Cape Hen. The casual occurrences of *Œstrelata haesitata*, *Œ. brevipes*, and *Œ. neglecta* in the British Islands are wonderful instances of the wandering habits of these small fulmars. The accounts given of the breeding and general life habits of these ocean wanderers, the gliding flight of which has so often beguiled the monotonous hours of the passengers on liners, are very interesting; and those who often have occasion to go on long voyages (in the southern seas especially), and take an interest in the birds they see, would do well to study the plates, at all events, in this fine work, and so have a chance of learning (roughly speaking) the names of the petrels which may on some days be seen from the deck in great numbers. But specimens of these birds are very rarely secured, and no opportunity should be lost of preserving any that by a lucky chance should come into the traveller's hands; for some species are known from single specimens only, and others from but little more.

The work will be completed in five quarterly parts. It is beautifully printed on rag paper, and we need only say of the plates that they are by Mr. Keulemans, and drawn and coloured under the most careful supervision. This means that they are as near perfection as it is possible for ornithological plates to be.

O. V. A.

#### OUR BOOK SHELF.

*Das Weltgebäude, Eine gemeinverständliche, Himmelskunde.* By M. Wilhelm Meyer. Zweite, umgearbeitete Auflage. Pp. xii+691. (Leipzig and Vienna: Bibliographisches Institut, 1908.) Price 16 marks.

TEN years ago we read the first edition of this work with considerable satisfaction, and the examination of the second edition has been interesting, since it shows